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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/603,729	06/24/2003	Katsumi Yamamoto	8228.P015	3361

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EXAMINER	
MADDEN, GREGORY VINCENT	

ART UNIT	PAPER NUMBER
2622	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/603,729	YAMAMOTO, KATSUMI	
	Examiner	Art Unit	
	Gregory V. Madden	2622	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 June 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-19* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-19* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 June 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on June 18, 2007 has been entered.

Response to Arguments

Applicant's arguments filed June 18, 2007 have been fully considered but they are not persuasive.

First, in regard to claims 1, 5, 8, 12, and 15, the Applicant has amended the claims to include the limitation of "...wherein the micro-lens overlays a base portion of the raised ridge structure". The Applicant argues that neither the Tan (U.S. Pat. 6,043,481) nor the Assadi (U.S. Pat. 6,166,369) reference teaches that the micro-lens overlays a base portion of the raised ridge structure (See Remarks, Pg. 7). The Examiner respectfully disagrees. Specifically, noting the Tan reference, Fig. 9B and Col. 5, Lines 20-39 shows that the photosensitive polymer 18A is heated (or "reflowed") so as to form a convex micro-lens contained within the raised ridge structure (ridge elements 19 of contoured surface 10). While the Applicant contends that Tan only shows that the convex surface elements (or micro-lenses) 18A are disposed only over depressed portions 20, the Examiner believes that Fig. 9B clearly shows that micro-lens 18A of Tan abuts, or vertically "overlays", a base portion of the raised ridge structure. Combining the raised ridge structure with a triangular cross-section, as taught by Assadi, with the micro-lens forming method of Tan, the Examiner believes that the micro-lens would indeed overlay a base portion of the triangular cross-section raised ridge structure, as the reflow process involves heating the lens material so

as to conform to the confines of the raised ridge structure, and thus overlay at least a base portion of that raised ridge structure. For this reason, the Examiner believes that Tan in view of Assadi does teach the limitations of newly-amended claims 1, 5, 8, 12, and 15, as will be set forth in further detail below.

Finally, the Applicant has further amended claim 15 to recite the limitation of "...isotropically etching the top planarizing layer..." to form the raised ridge structures having a triangular cross-section. The Applicant argues that the Assadi reference only discloses forming the raised ridge structures via a photolithographic technique, not the use of isotropic etching (See Remarks, Pg. 8). Again, the Examiner respectfully disagrees. While Assadi does teach the method of forming the reflective surfaces (or ridge structures) 12 using the photolithographic-type technique in Col. 3, Lines 25-36, this is not the only technique taught by Assadi. Noting Col. 2, Line 54 – Col. 3, Line 11, Assadi also teaches a technique of etching the reflective surfaces 12 "...using a techniques comparable to that utilized in connection with forming photoresists". As is taught in detail in Col. 2, Line 54 – Col. 3, Line 11, an etchant (diluted acid or base water solution) is used to chemically remove material from the substrate, and thus isotropic etching occurs to form the reflective surfaces (or ridge structures) 12. For the above reasons, the Examiner believes that Tan in view of Assadi does teach the limitations of newly-amended claim 15, and the rejection to the claim will be set forth below.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 6, 8-10, 13, and 15-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan et al. (U.S. Pat. 6,043,481) in view of Assadi et al. (U.S. Pat. 6,166,369).

First, regarding **claim 1**, the Tan reference teaches an image sensor comprising a plurality of pixels formed in a semiconductor substrate (substrate 12), each pixel including a light sensitive element (optoelectronic elements 14), a micro-lens (micro-lens element 18) over each of the light sensitive elements, and a raised ridge structure (ridge elements 19) surrounding each of the micro-lenses, wherein the raised ridge structure (19) at least partially supports the micro-lens (as shown in Fig. 9b), and further wherein the micro-lens (18) overlays a base portion of the raised ridge structure, as such an overlay is inherent in the reflow process of forming the micro-lens (18) between the ridge elements (19). Please refer to Figs. 4 and 9b, and Col. 3, Lines 35 – Col. 4, Lines 10. What the Tan reference fails to specifically teach is that the raised ridge structure has a triangular cross-section. However, the Assadi reference illustrates in Fig. 3 and discloses in Col. 2, Lines 5-8 and Lines 26-48 an image sensor comprising a raised ridge structure (reflective structure 12) having a triangular cross-section surrounding a micro-lens (micro-lens 24) over a photosensitive device (20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included the raised ridge structure having a triangular cross-section, as taught by Assadi, with the image sensor of Tan. One would have been motivated to do so because as Assadi teaches in Col. 2, Lines 42-51, having a raised ridge structure with a reflective triangular cross-section allows more light to be reflected to the micro-lens for diffraction towards the photosensitive device, thereby improving the fill factor of the photosensitive device.

Next, considering **claim 2**, the Tan reference teaches the limitations above, and while Tan does teach that a raised ridge structure (19) is located around the periphery of each micro-lens (18), Tan does not specifically disclose that the raised ridge structure is circular. However, the Assadi reference does teach a raised ridge structure (reflective surfaces 12) that surrounds each micro-lens and circularly arranged around each photosensitive device (20) (See Col. 2, Lines 26-48 and Fig. 3).

As for **claim 3**, again the limitations of claim 1 are taught above, and the Tan reference illustrates in Figs. 4 and 9b that the raised ridge structure (19) confines the micro-lens (18).

Considering **claim 6**, the limitations of claim 1 are taught above, and Tan further discloses that the raised ridge structure (19) is formed from the same material (i.e. the raised ridge structure is part of light transmissive layer member 16) that underlies the micro-lenses (18). See Fig. 4 and Col. 3, Lines 37-50.

In regard to **claim 8**, as is similarly disclosed above with respect to claim 1, the Tan reference teaches pixel of an image sensor comprising a light sensitive element (optoelectronic elements 14) formed in a semiconductor substrate (substrate 12), a micro-lens (micro-lens element 18) over the light sensitive element, and a raised ridge structure (ridge elements 19) surrounding the micro-lens, wherein the raised ridge structure at least partially supports the micro-lens, wherein the micro-lens (18) overlays a base portion of the raised ridge structure, as such an overlay is inherent in the reflow process of forming the micro-lens (18) between the ridge elements (19). Please refer to Figs. 4 and 9b, and Col. 3, Lines 35 – Col. 4, Lines 10. What the Tan reference fails to specifically teach is that the raised ridge structure has a triangular cross-section. However, the Assadi reference illustrates in Fig. 3 and discloses in Col. 2, Lines 5-8 and Lines 26-48 an image sensor comprising a raised ridge structure (reflective structure 12) having a triangular cross-section surrounding a micro-lens (micro-lens 24) over a photosensitive device (20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included the raised ridge structure having a triangular cross-section, as taught by Assadi, with the image sensor of Tan. One would have been motivated to do so because as Assadi teaches in Col. 2, Lines 42-51, having a raised ridge structure with a reflective triangular cross-section allows more light to be reflected to the micro-lens for diffraction towards the photosensitive device, thereby improving the fill factor of the photosensitive device.

In regard to **claim 9**, Tan in view of Assadi teaches the limitations of claim 8 above, and while Tan does teach that a raised ridge structure (19) is located around the periphery of each micro-lens (18), Tan does not specifically disclose that the raised ridge structure is circular. However, the Assadi reference does teach a raised ridge structure (reflective surfaces 12) that surrounds each micro-lens and circularly arranged around each photosensitive device (20) (See Col. 2, Lines 26-48 and Fig. 3).

Regarding **claim 10**, again the limitations of claim 8 are taught above, and the Tan reference illustrates in Figs. 4 and 9b that the raised ridge structure (19) confines the micro-lens (18).

As for **claim 13**, Tan in view of Assadi teaches the limitations of claim 8 above, and Tan further discloses that the raised ridge structure (19) is formed from the same material (i.e. the raised ridge structure is part of light transmissive layer member 16) that underlies the micro-lenses (18). See Fig. 4 and Col. 3, Lines 37-50.

Next, regarding **claim 15**, Fig. 9B and Col. 5, Lines 20-38 of the Tan reference teaches a method of forming a pixel of an image sensor comprising forming a light sensitive element (14) in a semiconductor substrate (12), forming a top planarizing layer (16) over the light sensitive element, forming a raised ridge structure (19) over the top planarizing layer, the raised ridge structure encompassing the light sensitive element, and forming a micro-lens (18) within the interior of the raised ridge structure and over the light sensitive element, wherein the raised ridge structure at least partially supports the micro-lens, and further wherein the micro-lens (18) overlays a base portion of the raised ridge structure, as such an overlay is inherent in the reflow process of forming the micro-lens (18) between the ridge elements (19). What the Tan reference fails to specifically teach is that the raised ridge structure has a triangular cross-section, and that the top planarizing layer is isotropically etched to form the raised ridge structure. However, as illustrated in Fig. 3 and disclosed in Col. 2, Lines 5-8, Col. 2, Lines 26-48, and Col. 2, Line 54 – Col. 3, Line 11, the Assadi reference teaches an image sensor comprising a raised ridge structure (reflective structure 12) that is formed by isotropically etching the top

planarizing layer (i.e. chemically removing portions of the top planarizing layer in both directions), wherein the raised ridge structure has a triangular cross-section surrounding a micro-lens (micro-lens 24) over a photosensitive device (20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included the raised ridge structure having a triangular cross-section, as taught by Assadi, with the image sensor of Tan. One would have been motivated to do so because as Assadi teaches in Col. 2, Lines 42-51, having a raised ridge structure with a reflective triangular cross-section allows more light to be reflected to the micro-lens for diffraction towards the photosensitive device, thereby improving the fill factor of the photosensitive device.

In regard to **claim 16**, the limitations of claim 15 are taught above, and Tan further discloses that the raised ridge structure (19) is formed in the top planarizing layer (16). Please refer to Figs. 4 and 9B, and Col. 3, Lines 41-45.

Next, considering **claim 17**, the limitations of claim 15 are set forth above, and the Tan reference illustrates in Figs. 4 and 9b that the raised ridge structure (19) confines the micro-lens (18).

As for **claim 18**, again the limitations of claim 15 are taught above, but Tan does not specifically teach that the raised ridge structure is a closed shape. However, as is illustrated in Fig. 2 and taught in Col. 2, Lines 30-34, the Assadi reference discloses that the raised ridge structure is a closed shape (e.g. a circle or orthogonal pattern).

Claims 4 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan et al. (U.S. Pat. 6,043,481) in view of Assadi et al. (U.S. Pat. 6,166,369), further in view of Applicant's admitted prior art.

In regard to **claims 4 and 11**, the limitations of claims 1 and 8 are respectively taught above, but Tan in view of Assadi does not specifically disclose that the micro-lenses are formed from polymethylmethacrylate or polyglycidylmethacrylate. However, noting Para. [0025] of the Applicant's

current specification, the Applicant discloses that the use of acrylics such as polymethylmethacrylate or polyglycidylmethacrylate is common in forming micro-lenses. Thus, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have formed the micro-lenses of Tan in view of Assadi using polymethylmethacrylate or polyglycidylmethacrylate. One would have been motivated to do so because the use of common materials reduces manufacturing costs and the need for additional specialized manufacturing equipment.

Claims 5, 7, 12, 14, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan et al. (U.S. Pat. 6,043,481) in view of Assadi et al. (U.S. Pat. 6,166,369), further in view of Nakai (U.S. Pat. 5,396,090).

Next, considering **claim 5**, the limitations of claim 1 are taught above by Tan in view of Assadi, but the combination fails to specifically disclose that the raised ridge structures have a height of about 0.2 microns. However, the Nakai reference teaches an image sensor having a plurality of micro-lenses (66) surrounded by a raised ridge structure (partition wall 51), wherein the partition wall 51 can have a height of 0.2 microns, as taught in Figs. 1 and 5, and Col. 4, Line 46 – Col. 5, Line 50. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have incorporated the raised ridge structure having a height of 0.2 microns, as taught by Nakai, with the raised ridge structure of Tan in view of Assadi. One would have been motivated to do so because by limiting the height of the raised ridge structure, the dimensions of the image sensor can remain small, therefore allowing for use in compact imaging devices.

As for **claim 7**, again the limitations of claim 1 are taught above, but Tan in view of Assadi does not disclose the use of a color filter layer between the micro-lenses and the light sensitive elements. However, the Nakai reference teaches the use of a color filter layer in the image sensor in Col. 6, Lines 28-31.

Regarding **claim 12**, the limitations of claim 8 are taught above, but Tan in view of Assadi fails to specifically disclose that the raised ridge structures have a height of about 0.2 microns. However, the Nakai reference teaches an image sensor having a plurality of micro-lenses (66) surrounded by a raised ridge structure (partition wall 51), wherein the partition wall 51 can have a height of 0.2 microns, as taught in Figs. 1 and 5, and Col. 4, Line 46 – Col. 5, Line 50.

In regard to **claim 14**, again the limitations of claim 8 are taught above, but Tan in view of Assadi does not disclose the use of a color filter layer between the micro-lenses and the light sensitive elements. However, the Nakai reference teaches the use of a color filter layer in the image sensor in Col. 6, Lines 28-31.

Finally, considering **claim 19**, Tan teaches the limitations of claim 15, but the method of Tan in view of Assadi fails to teach the use of a color filter layer between the micro-lenses and the light sensitive elements. However, the Nakai reference teaches the use of a color filter layer in the image sensor in Col. 6, Lines 28-31.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

Hoopman et al. (U.S. Pat. 5,519,539): Refer to Figs. 15-17 and Col. 7, Line 35 – Col. 9, Line 17

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Gregory V. Madden whose telephone number is 571-272-8128. The examiner can normally be reached on Mon.-Fri. 8AM-5PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ngoc Yen Vu can be reached on 571-272-7320. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Gregory Madden
July 24, 2007

NGOC-YEN VU
SUPERVISORY PATENT EXAMINER